

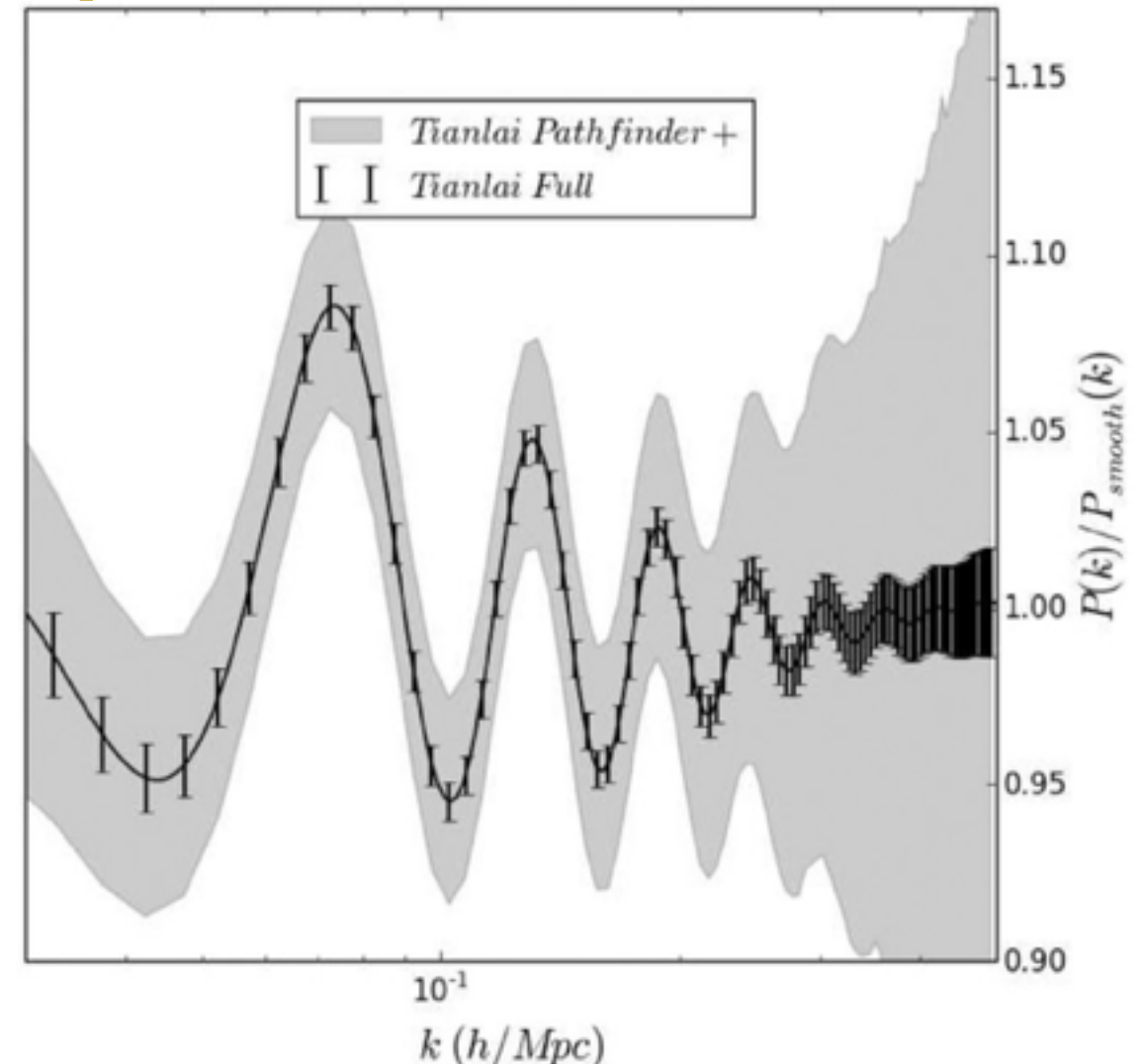
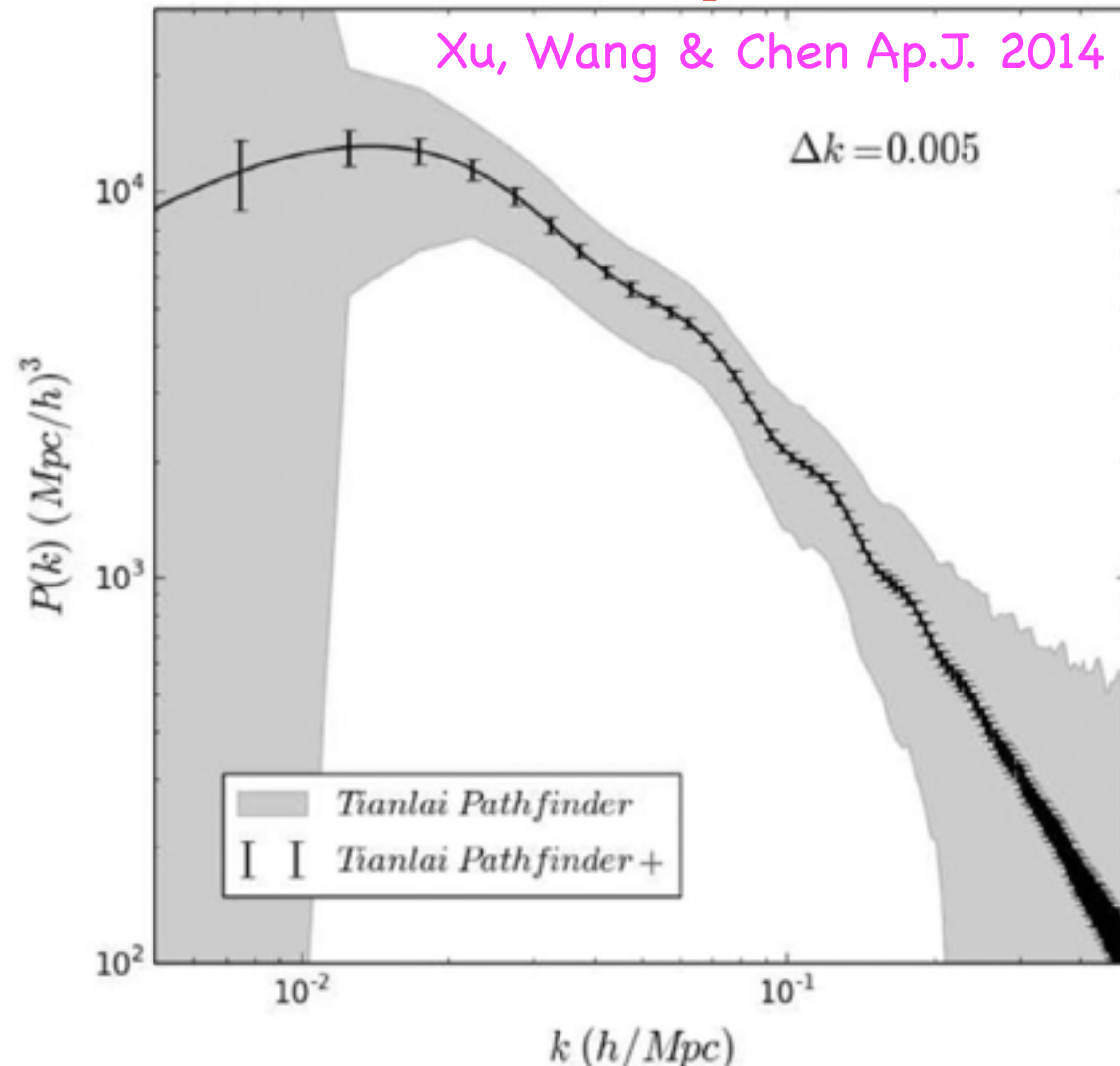
# The Tianlai Project

A Dark Energy Radio Observation Experiment



# Science Forecast: P[k] & DETF FoM

timeline: **pathfinder**  $\Rightarrow$  **pathfinder+**  $\Rightarrow$  **full**



pathfinder(+) surveys 50 Gpc<sup>3</sup> ~DES

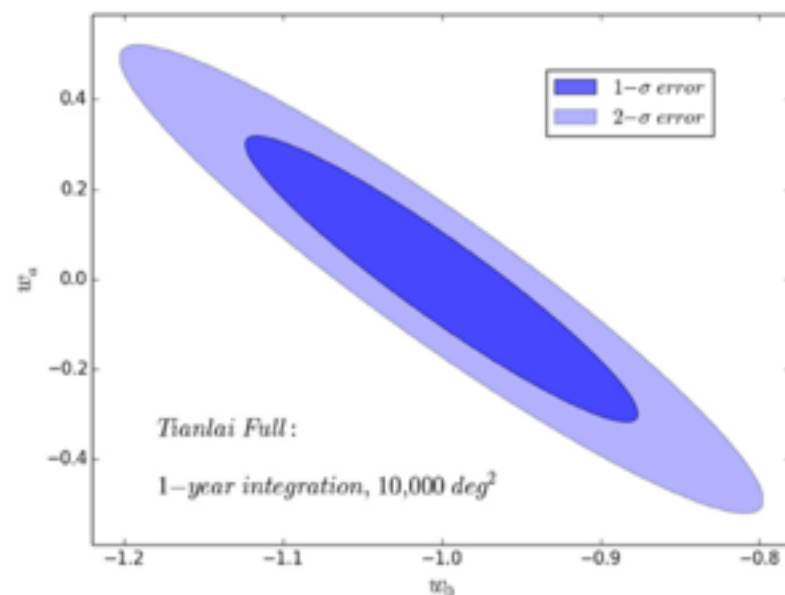
Independent projection: (Bull et al. 2015)

DETF FoM

full: 383

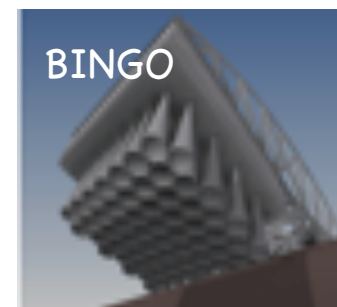
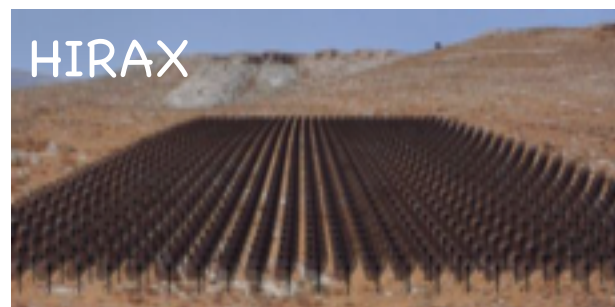
compare to Stage IV: 400

DES: 72 (BAO) 264 (total)



# Expected Main Result

## Demonstration of Hydrogen Intensity Mapping for Future Surveys





# The Tianlai (Heavenly Sound) Project

Collaboration since 2010

NAOC, Xinjiang Observatory, CETC-54, Institute of Automation,  
Hangzhou Dianzi U.

LAL/IN2P3 (Ansari, Campagne, Moniez), Obs. Paris (Martin, Colom),  
IRFU-CEA(Magneville, Yeche)

US: CMU(Peterson), U. Wisconsin (Timbie), Fermilab (Stebbins)

CITA(Pen), KASI (Song), ASIAA(Chang), ...

2016 Annual Collaboration Meeting:

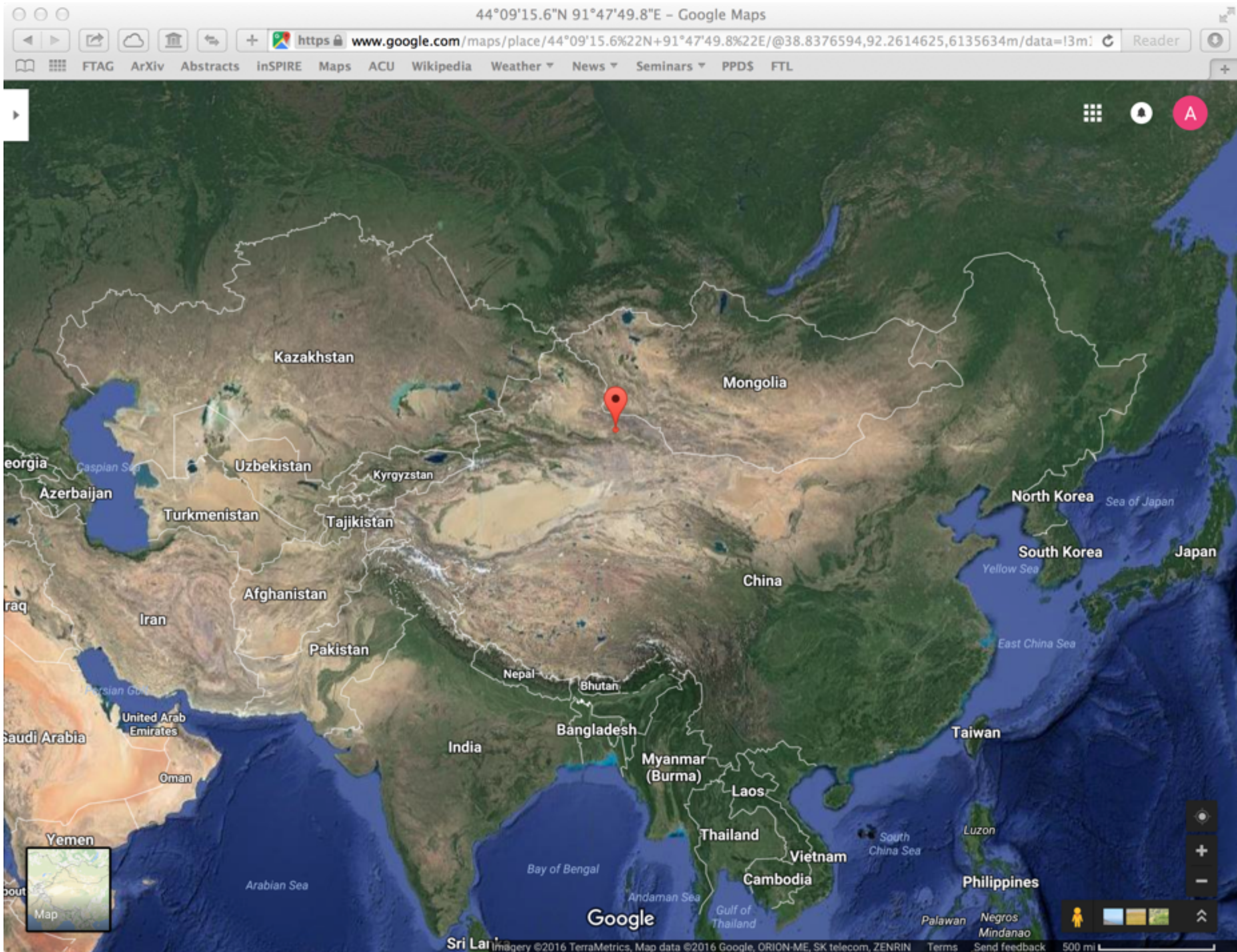
**next Mon/Tue @ Fermilab**

**You're invited!**

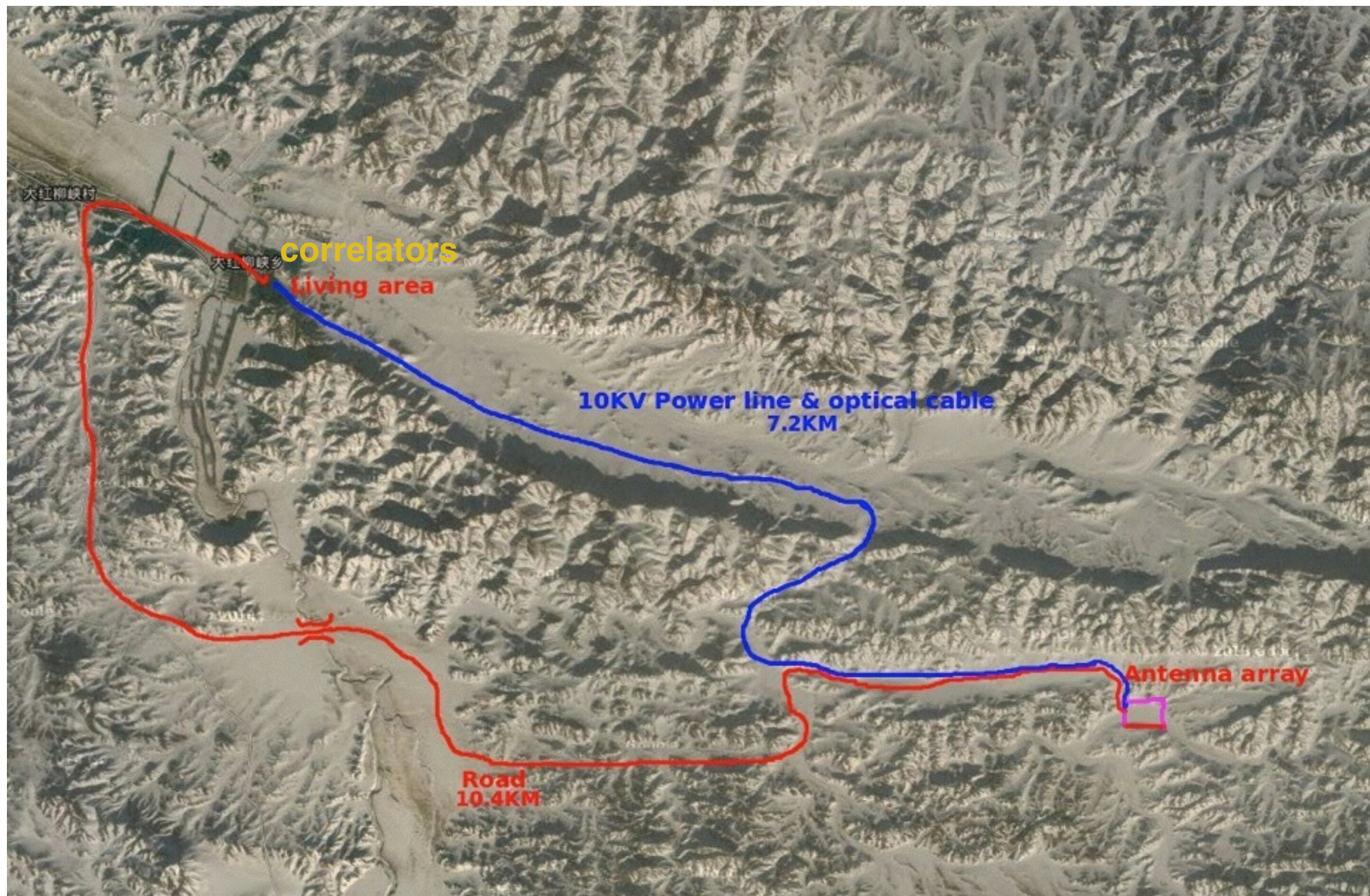


The concept of  
“**tianlai**”-- the  
**heavenly sound** was  
coined by ancient  
Chinese philosopher  
Zhuang-Zi (Chuang-  
Tzu, 369BC-286BC)











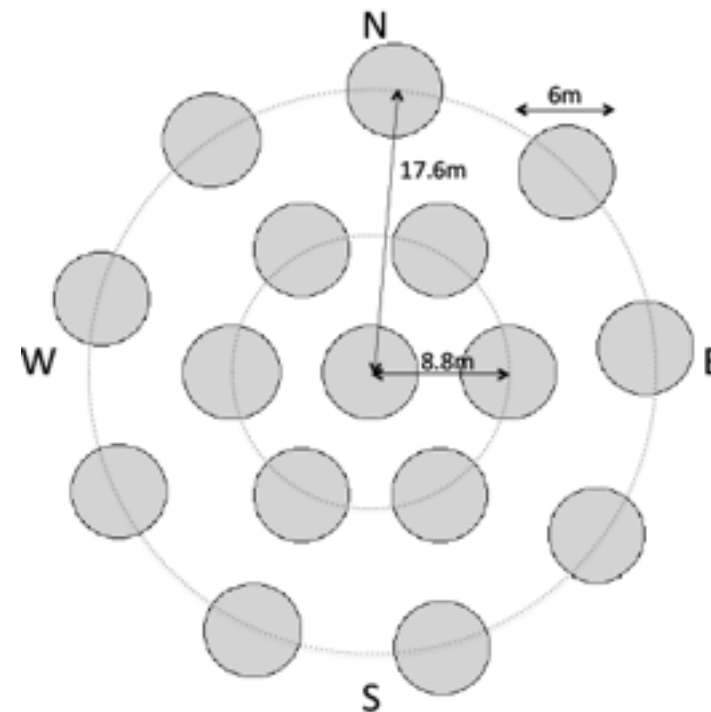
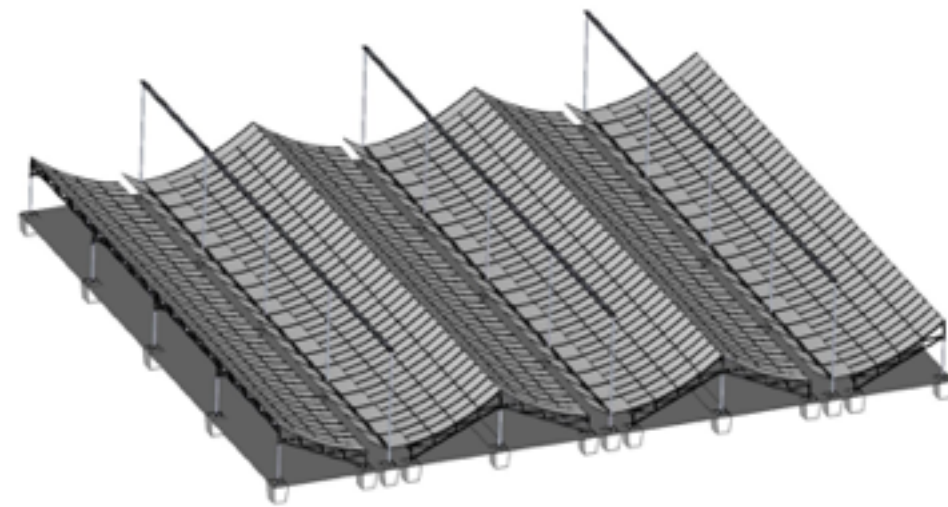
# Tianlai Facility



# Tianlai Pathfinder Configuration

Pathfinders to demonstrate basic principle  
and encounter all issues rapidly

- **Cylinder Array** 3 x 15m x 40m cylinders  
96 dual polarization feeds
- **Dish Array** 16 x 6m dishes  
16 dual polarization feeds
- **Band** 700-800MHz ( $0.77 < z < 1.3$ )  
1024 channels ( $\delta\nu=100\text{kHz}$   $\delta z=0.0002$ )  
tunable in 600-1420MHz
- **Pathfinder+ Cylinder Array**  
216 dual polarization feeds
- **Full Cylinder Array** 8 x 15m x 120m  
2048 dual polarization feeds  
400-1420MHz





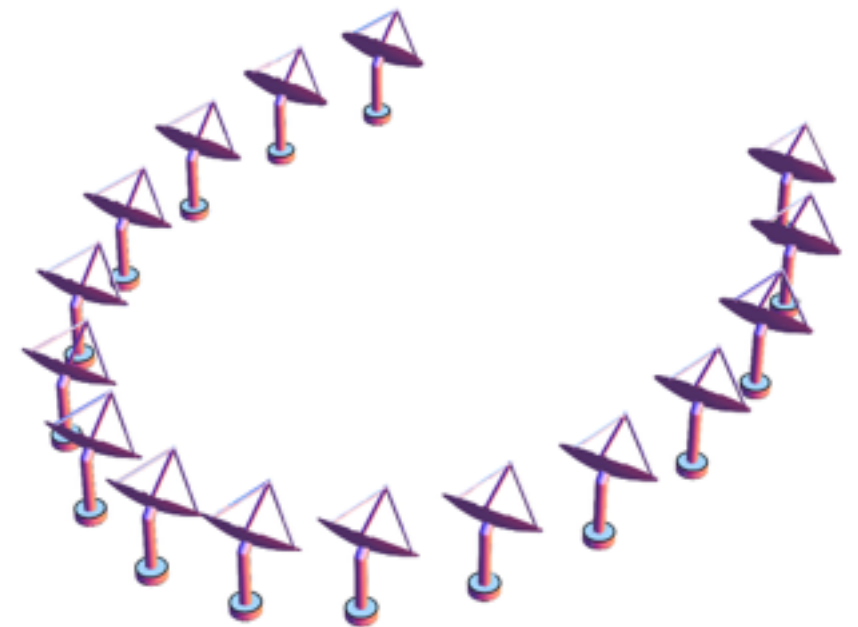
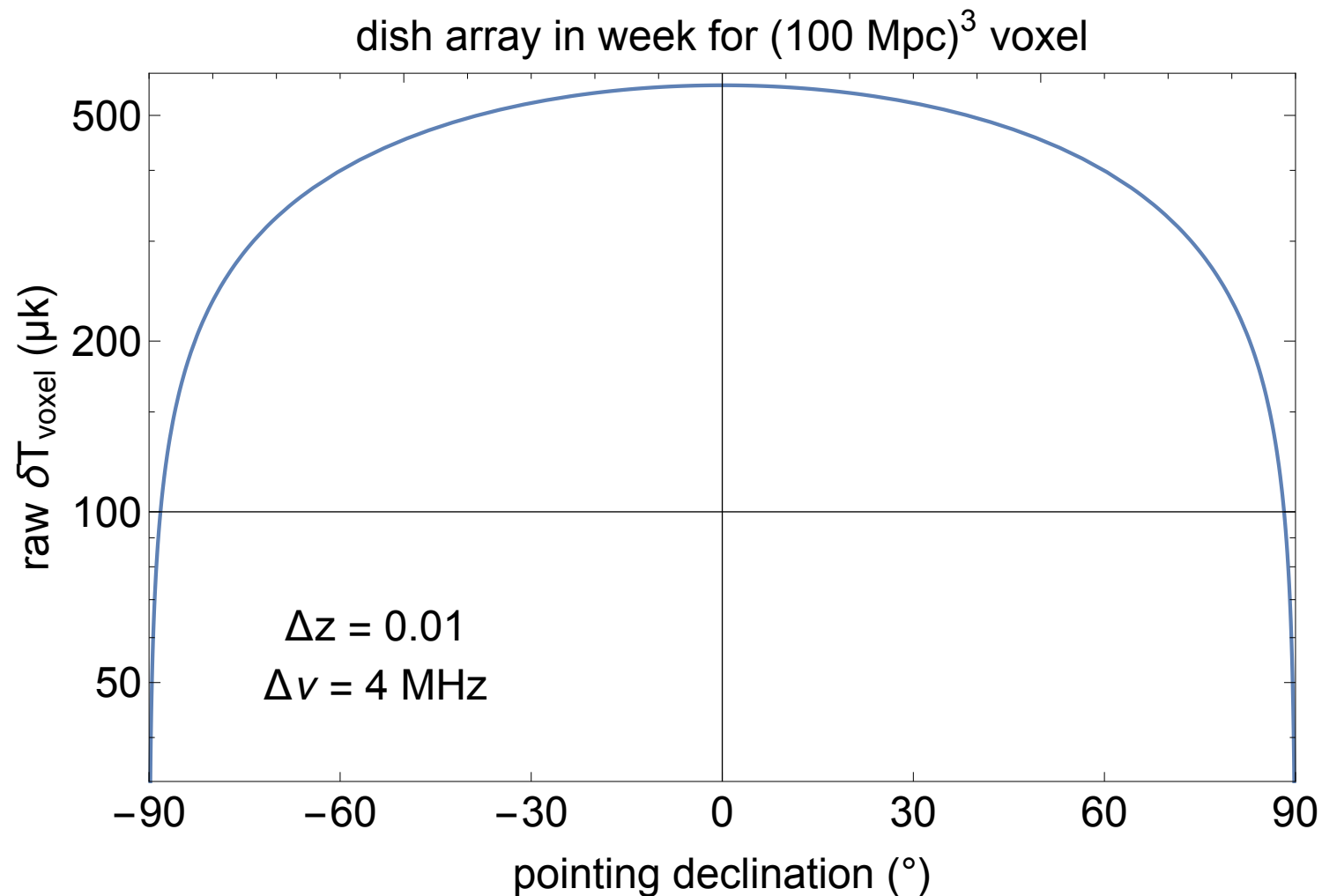
# Pathfinder Highly Configurable Transit Telescope

- Tuneable:
  - $600 < \nu < 1420\text{Mhz}$  ( $0 < z < 1.36$ ) [fixed 100 Mhz bandwidth]
- Cylinders:
  - equal/unequal spacing of feeds on cylinder
  - feed placement on cylinders may be same or different
    - redundancy vs broader u-v coverage (less mode mixing)
- Dishes:
  - pointable (no tracking)
  - arrangeable in any ground configuration

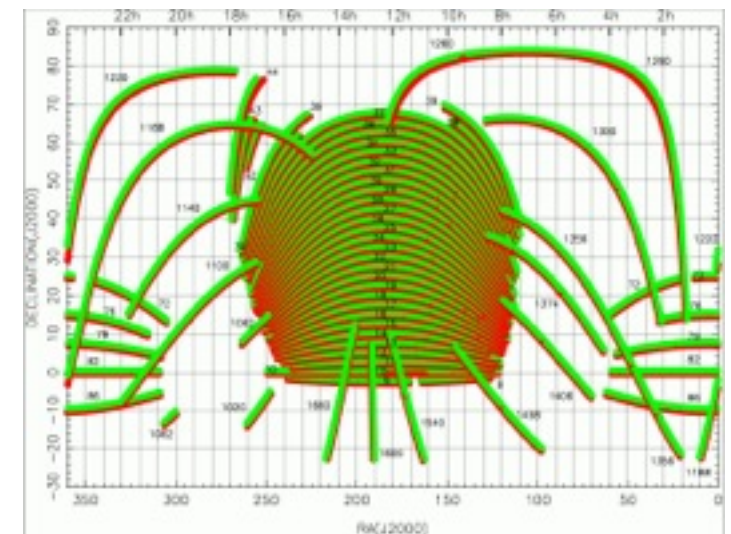
R&D: plan to play with all the knobs



# e.g. Dish Array as Polarscope

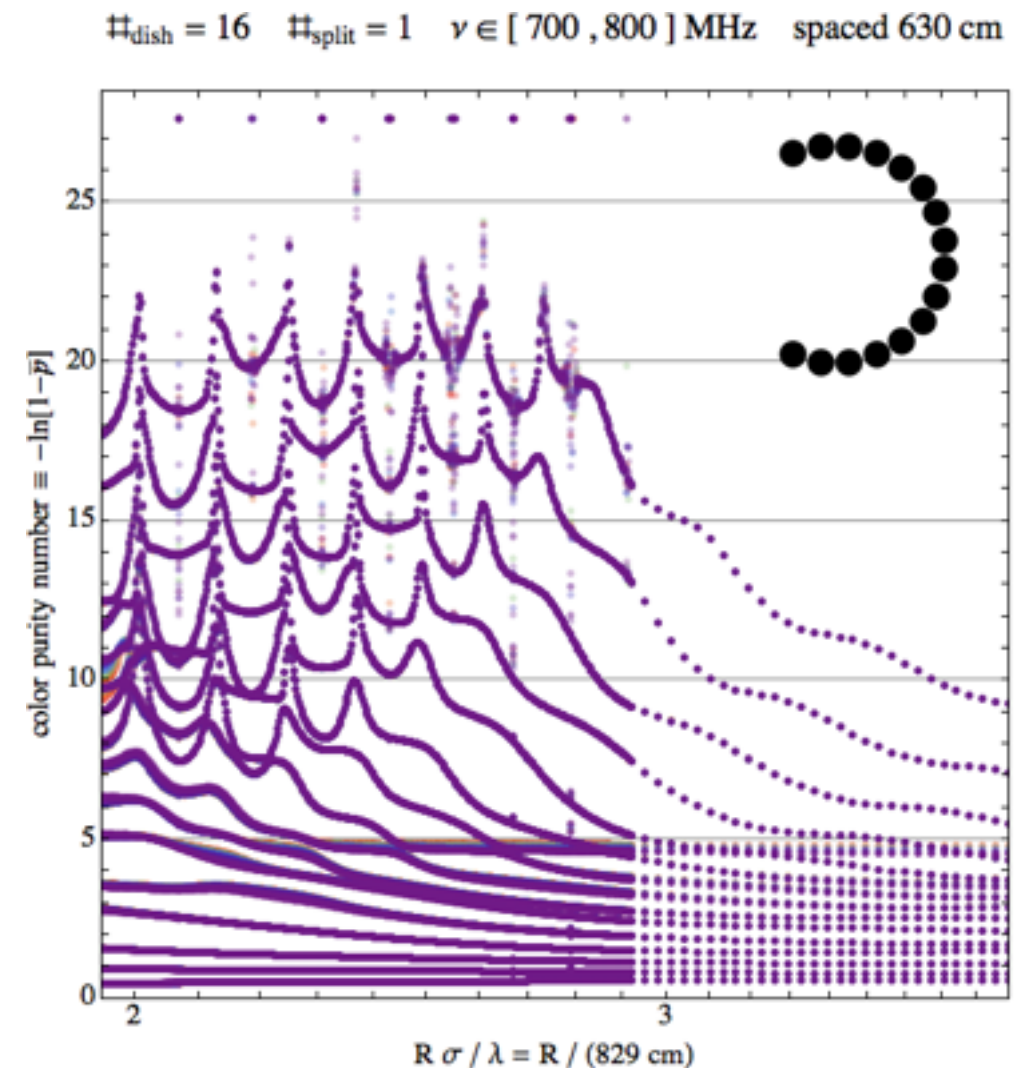
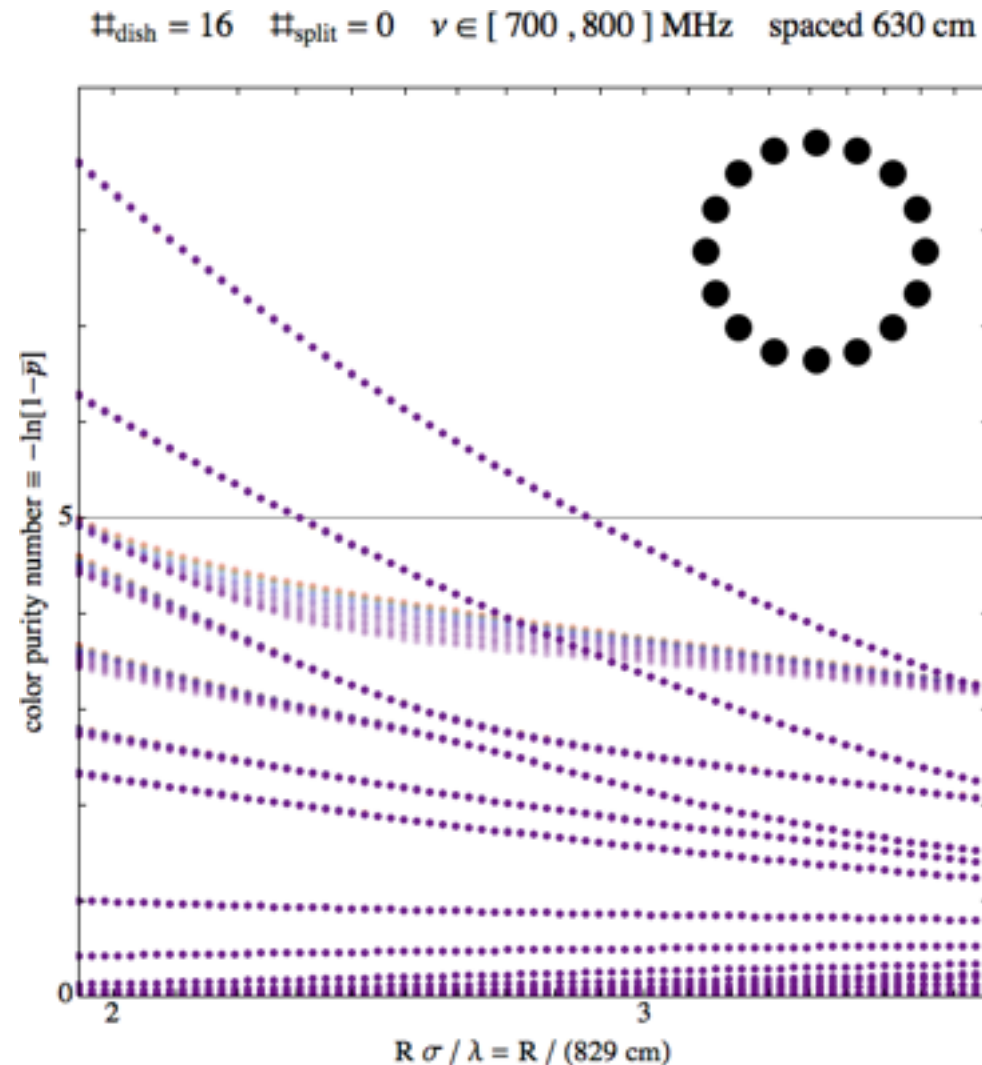


- By pointing disk array toward pole will integrate down to low map noise temperature very rapidly.
- **An NCP optical redshift survey to compare to would be extremely useful**





# e.g. Optimizing Dish Array Design



- By rearranging dish array elements (to within a fraction of  $\lambda$ ) one can decrease the amount of mode mixing in synthetic beams by a large amount.
- mode mixing - aliasing of angular modes into frequency modes - which effects degree one can remove foreground




# U.S. Participation

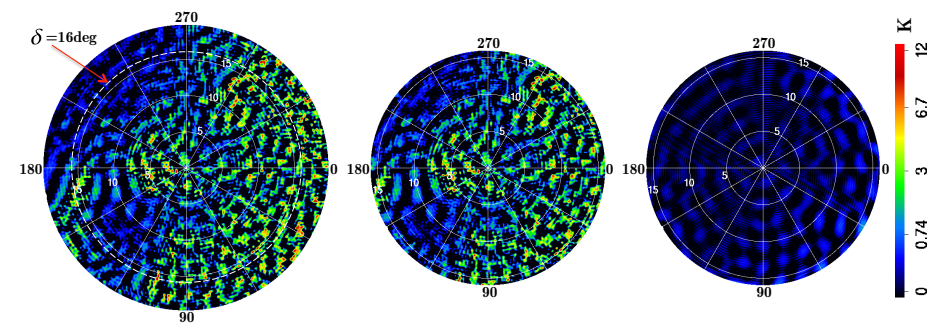
- Currently just 3: Peterson / Stebbins / Timbie
  - **collaboration open to new participants**
- Support by Funding Agencies:
  - Timbie (PI) / AS recently received NSF-AAG Grant
  - **Tianlai Analysis Center**
    - storage at FNAL
    - computing: Open Science Grid computing
  - **we have a postdoc opening now!**
- As with many projects Tianlai is manpower limited

# Forecasting and Simulations

## Sky reconstruction from transit visibilities: PAON-4 and Tianlai Dish Array

Jiao Zhang<sup>1,2,3</sup>, Reza Ansari<sup>2</sup> , Xuelei Chen<sup>1,3,4</sup>, Jean-Eric Campagne<sup>2</sup>,  
Christophe Magneville<sup>5</sup>, and Fengquan Wu<sup>1</sup>

<sup>1</sup>Key Laboratory of Computational Astrophysics, National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China  
<sup>2</sup>Université Paris-Sud, LAL, UMR 8607, F-91898 Orsay Cedex, France & CNRS/IN2P3, F-91405 Orsay, France  
<sup>3</sup>University of Chinese Academy of Sciences, Beijing 100049, China  
<sup>4</sup>Centre for High Energy Physics, Peking University, Beijing 100871, China  
<sup>5</sup>CEA, DSM/IRFU, Centre d'Etudes de Saclay, F-91191 Gif-sur-Yvette, France



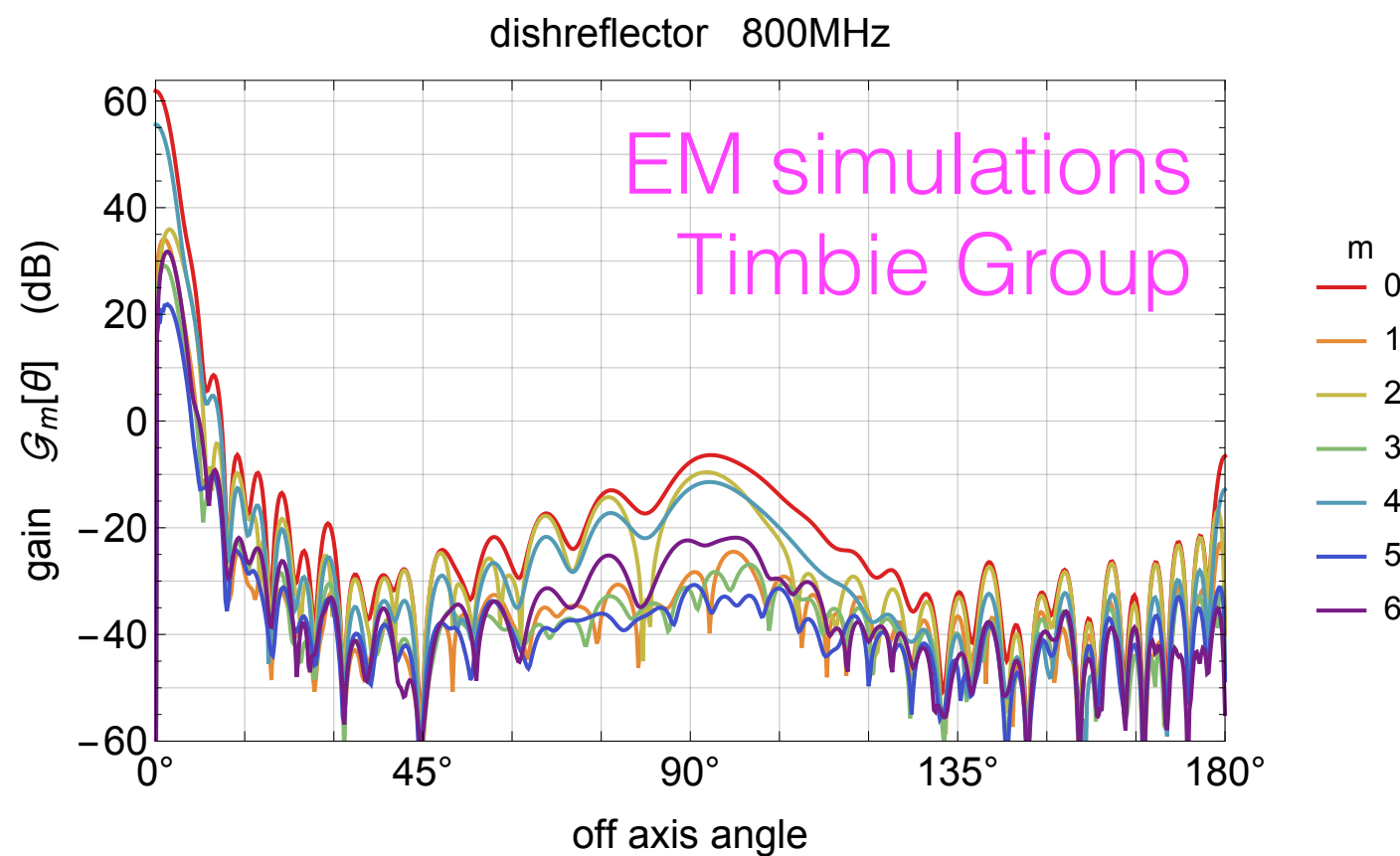
THE ASTROPHYSICAL JOURNAL, 798:40 (10pp), 2015 January 1  
© 2015. The American Astronomical Society. All rights reserved.

doi:[10.1088/0004-637X/798/1/40](https://doi.org/10.1088/0004-637X/798/1/40)

## FORECASTS ON THE DARK ENERGY AND PRIMORDIAL NON-GAUSSIANITY OBSERVATIONS WITH THE TIANLAI CYLINDER ARRAY

YIDONG XU<sup>1</sup>, XIN WANG<sup>2</sup>, AND XUELEI CHEN<sup>1,3</sup>

<sup>1</sup> National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China  
<sup>2</sup> Department of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218, USA  
<sup>3</sup> Center for High Energy Physics, Peking University, Beijing 100871, China  
Received 2014 August 11; accepted 2014 October 24; published 2014 December 18





# Timeline

- 2014:
  - basic infrastructure: roads, buildings, power, optical fibers
  - electronics design
- 2015:
  - scientific infrastructure: reflectors finished
  - much of electronics installed
  - first fringe
  - engineering / debugging
- 2016:
  - engineering / debugging
  - astronomical imaging of bright sources using dish array
  - just started scans with cylinders

# ಧನ್ಯವಾದಗಳು

